REMARKS

This is in response to the Office Action mailed September 30, 2005. In response to the Examiner's Detailed Action, by this amendment, claims 1-25 remain in this application.

Claim Rejections – 35 USC § 112

In the Office Action, claim 19, was rejected under 35 U.S.C. 112, second paragraph, in that line 22 thereof recites the limitation "said *external* combustion engine" and that there is insufficient antecedent basis for this limitation in the claim. Applicant agrees with the Examiner and the necessary correction "said *internal* combustion engine" has been made in amended claim 19. This obvious mischaracterization is regretted.

Claim Rejection – 35 USC § 102

Claims 1-15, 19-24 were rejected under 35 U.S.C. 102 (b) as being anticipated by Romey et al. (4,835,971). The Examiner's attempted detailed reading of the noted claims on the structure of Romey et al. will not be repeated here in the interest of brevity but Applicant would like to clarify what he believes to be the teachings of Romey et al., starting with the Abstract, which states:

> *"...The invention overcomes the problem of injecting into the combustor of a jet engine at an angle which may be adjustable over a predetermined range to enhance combustion of the fuel..."*

Continuing with col. 3, paragraph 2, starting on line 13, Romey et al. note:

> *"...nozzle may be rotated about the center axis of the fuel supply tube to permit orientation of the support flange prior to <u>securing the nozzle</u> to a support member."* (Emphasis added).

Further continuing, with reference to claim 1 thereof, lines 14, 15:

> *"...and for securing said first sheath at said position,".*

The problem addressed by the Romey et al. device is to allow angular adjustability <u>prior to locking the tip feature in place.</u> The Lehtinen device of the present

invention will not work if the nozzle tip is secured. While there are similarities between Romey et al. and the Lehtinen devices, in that they are both fuel nozzles and have spherical tip features, they solve two very different problems.

In the Romey et al. device, once the nozzle tip is secured, the fuel tube 14 is fixed at the inlet end and the tip end. In operation, the outer sheath will heat up and grow. The fuel tube 14 will remain cool and a thermal pull or fight will occur between the inner cool and outer hot components. As best seen in Fig. 2 thereof, the stresses on fuel tube 14 will be driven into the end connections near threaded jam nut 29.

The stresses on fuel tube 14 in the Romey et al. device may have been acceptable due to the small size (the distance from flange 12 to tip 40) and the lower compressor discharge temperatures of jet engines of this era (filing date of the Romey et al. patent application is 3/02/1987). These lower temperatures limit the amount of thermal growth.

The Romey et al. device actually suffers from the problem of high stresses at the tube ends, which is exactly the problem that is being addressed by the Lehtinen structure of the present invention.

Claim Rejections – 35 USC § 103

In a first rejection, the Examiner rejected claims 1-25 under 35 USC 103(a) as being unpatentable over Romey et al. (4,835,971) in view of either Ben-Porat (4,454,711) or Pidcock et al. (4,693,074). The Examiner notes that Romey et al. teach various aspects of the claimed invention but do not teach the adaptor member of the housing 16, 48 having a curved surface. Ben-Porat and Pidcock et al. are cited by the Examiner for their spherical surface teachings.

Ben-Porat, in his Abstract notes *"... including a ball and socket joint which is placed within a structure so as to permit movement in the three Cartesian directions...The self aligning fuel nozzle assembly reduces the development of local stresses between the swirler and the fuel nozzle..."*

Applicant is of the opinion that the Ben-Porat device uses free movement between adjacent components to limit the load transfer and therefore reducing local stresses. The left margin of Fig. 4 thereof shows the allowable relative radial movement "Δ" between

lip portion 90 and aperture 78. Without this allowable movement, large loads would be transferred to the fuel injector. This technique, as taught by Ben-Porat, is used in every gas turbine combustor in use today, however, inside of a fuel nozzle, this technique <u>cannot</u> be used since the required radial movement would be too large to accommodate within the shroud and the injector tip. The current practice for fuel nozzles is to fix the cold tip to the end of the injector.

Continuing with Pidcock et al. (4,693,074), this device appears to read directly on the noted Ben-Porat structure, i.e., they appear to address the same problem with the same features. By way of example, col. 2, starting on line 10, and claim 9, both state *...by locating means which allow relative movement of the fuel injector and convergent/divergent pot axially, radially and circumferentially to limit the transmission of loads to the fuel injector."*

While Figs. 12-14 do show spherical tip features, there are also additional features which allow radial movement of the nozzle tip. Specifically, in Fig. 12, there is a sliding interface between rings 92, 94, and annular member 62. Without this latter movement, large loads would be transferred to the fuel injector. Thus, the key features of the Pidcock et al. device allow relative movement and limit loads.

The spherical features of the Lehtinen device of this invention must be used in conjunction with additional features, in a manner different from those of Romey et al., Ben-Porat and Pidcock et al., in order to solve a different problem. That problem, is not reducing, but transferring and managing the loads from the hot to the cold components. The nozzle tip components <u>move as but one unit</u> and there is only one degree of freedom, not six.

If the Ben-Porat or Pidcock et al. devices were used on the internal components of the fuel nozzle, the fuel injection tip would retract and shift inside of the outside structure of the fuel nozzle. This would lead to interference of the fuel spray by the noted outer structure. Therefore, the tip must move as a single unit.

Applicant agrees with the Examiner's statement, starting on page 6, line 7, of the Office Action, as it applies to combustor design, namely: *"Romey et. al. is cited as a*

teaching reference to show that it is old and well known in the art to employ relative movement between the fuel nozzle and the shroud." While the constructions detailed in Romey et al. and Ben-Porat are the bases for all modern combustors, this construction cannot be applied to or transferred to the internal design of fuel nozzles.

In a second rejection, the Examiner rejected claims 1-15, 19-24, under 35 U.S.C. 103 (a) as being unpatentable over Richey et al. (4,735,044) in view of Romey et al. (4,835,971) and Pidcock et al. (4,693,074). In this rejection, Applicant does however take exception to the Examiner's statement that *"It would have been obvious to one of ordinary skill in the art to employ a spherical joint as shown in Figs. 12-14..."* of Pidcock et al. to accommodate pivoting and/or axial movement to accommodate thermal expansion between the nozzle and housing shroud of Richey et al.

Applicant is very familiar with the Richey et al. design since the assignee of the present invention actually manufactures this device. The primary/secondary fuel tubes 30, 32, of Richey et al., are rigidly connected to inlet 23 and the nozzle tip 19. As previously discussed, this type of configuration is needed for proper fuel injection (without spray interference). This structure is also the state of the art design described on page 2, first full paragraph, of the present application where it is noted as follows:

> *"In typical fuel injector assembly constructions, the fuel feed is fixedly attached at its inlet end and at its outlet end to the inlet fitting and nozzle, respectively..."*

Continuing with the last full paragraph on page 2 thereof, the present application notes:

> *"The unsolved problem with the noted prior art construction is that if the nozzle tip is unyieldingly, rigidly attached to the housing, the occurring high stresses are maximized at a transition zone between the fuel feed inner end and the adjoining nozzle end, which can result in early low fatigue failure of this assembly in the general area of the noted transition zone."*

Richey et al. teaches a method of constructing a concentric tube fuel injector which allows these tubes to thermally grow independently of one another. However, the nozzle does not pivot and the stresses will be driven into the end connections.

In yet a third rejection, the Examiner rejects claims 1-15, 19-24, under 35 U.S.C. 103 (a) as being unpatentable over Mains (5,570,580) in view of Romey et al. (4,835,971) and Pidcock et al. (4,693,074).

Since the Romey et al. and Pidcock et al. structures have already been discussed, in the interest of brevity this discussion will not be repeated here. Thus, turning to Mains, Applicant is very aware of its structure and operation since this patent is not only assigned to the assignee of the present invention but this device is also in current production. While the Mains structure does utilize a contoured outer housing, it does <u>not</u> have a contoured flexible feed designed to compensate for thermal expansion. The curve of the curved tube section, which is highlighted in Fig. 3, serves only to redirect (turn) the fuel flow. Specifically, thermal compensation of this design is accomplished via the use of sliding O-ring seals shown in Figs. 1 and 2. As the hot outer housing grows, the cool fuel tube remains unloaded due to the relative motion provided by the sliding of these seals.

In addition, Mains represents the state of the art as it pertains to rigidly attached tips. Specifically, Fig. 3 shows, and col. 4 staring at line 51, describes the rigid connections inside of the fuel injector tip as follows:

"As shown in Fig. 3, the main tip 15 includes a tip shroud 39 which is <u>connected</u> to the distal end 41 of the housing extension 35. <u>Connected</u> to the interior of the tip shroud 39 is a secondary orifice piece 43. <u>Connected</u> with the secondary orifice piece 43 is a primary orifice piece 45." (Emphasis added)

The connection of the fuel tubes to the fuel nozzle tip is also set forth in the Mains reference. It should be understood that this type of rigid tip construction is identified as prior art in the present application. If the sliding O-ring seals are removed, the fuel tube and the fuel tip structure will be thermally loaded. This condition is the problem statement set forth in the present application.

As a result of the Examiner's 35 U.S.C. 112 rejection, claim 19 has been amended to overcome same, and claims 9, 12 and 18 have been amended to correct minor antecedent problems. No new matter has been introduced.

In light of the above reasoning, it is respectfully requested that claims 1-15 and 19-24 are distinct from being anticipated by Romey et al. (4,835,971) and are in condition for allowance. In addition, it is respectfully submitted that (1) claims 1-25 are not unpatentable in view of the combination of Romey et al. in view of either Ben-Porat (4,454,711) or Pidcock et al. (4,693,074); or that (2) claims 1-15, 19-24 are not unpatentable over the combination of Richey et al. (4,735,044) in view of Romey et al. and Pidcock et al.; or that (3) claims 1-15, 19-24 are not unpatentable over Mains (5,576,588) in view of Romey et al. and Pidcock et al. It is deemed that claims 1-25 are in condition for allowance and prompt notice to that effect is respectfully requested.

Nevertheless, should the Examiner continue to believe otherwise, the Examiner is kindly requested to contact the undersigned attorney by telephone, should the Examiner believe that it would result in a furtherance of this matter.

Respectfully submitted,

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